Clinical Science Investigation (CSI) Canterbury: surgical gown length and blood inside gumboots

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Abstract

Background A gap between the bottom of gowns and the top of gumboots (commonly known as wellingtons or rubber boots outside of New Zealand) makes it possible for blood splashes to enter surgeons’ gumboots and contact skin, putting them at risk of exposure to HBV, HCV and HIV. This study investigated the prevalence of blood splashes inside gumboots used by surgical staff at a single hospital.

Method Ninety-four pairs of gumboots (91 from male surgeons, 3 from female surgeons) from the hospital operating theatres were used in this study. Each pair of boots was visually inspected for internal contamination with blood. Possible stains were checked using urine dipsticks to confirm the presence of blood.

Results Of the 94 pairs of gumboots checked, 55 pairs (58.5%) had blood staining on the inside lining. Eighty percent of blood stains were larger than 20 mm². None of the female surgeons’ gumboots were contaminated compared to 60% of the males’ pairs.

Conclusion A large proportion of the gumboots used in operating theatres were contaminated internally with blood. The results of this study suggest that longer gowns should be available to health care workers in operating theatres to reduce internal contamination of gumboots and minimise the chance of exposure to body fluids.

Workplace safety is an increasingly important issue in New Zealand. Across all industries we have seen improvements in the personal safety of workers.¹ Surgeons and those working alongside them in operating theatres are constantly being potentially exposed to the small but tangible risk of infection through contact with infected blood.

The blood borne infections that currently present the most danger to surgeons are Hepatitis B and C and HIV. Numerous protective measures have been taken to minimise these dangers, including gloves, gowns, eyewear and footwear.

Since 1952, when Beck helped surgeons realise the inadequacies of the muslin gowns used at the time, there has been significant interest in the efficacy of surgical barriers.² The gowns currently used at our hospital are reusable gowns designed by Standard Textile Healthcare that may be used up to 81 times before disposal. They use a polyester ComPel® surgical barrier to protect the wearer from contact with blood. In theatre they are supplied in the sizes large and extra-large. Large gowns measure 120 cm from collar to hem with extra large measuring 140 cm.

The first incarnation of the gumboot (Wellington boot) was a calfskin boot worn by Arthur Wellesley, the 1st Duke of Wellington. The polyvinyl chloride (PVC) version
that we are most familiar with today is commonly seen in surgical operating theatres throughout the world. Providing a strong and relatively impermeable cover for surgeon’s feet they seem like the ideal footwear from a safety viewpoint.

The ability of the garments mentioned above, to prevent transmission of infection, relies on the continuity of the barrier that they provide. By looking at the prevalence of blood inside surgeon’s gumboots this study aimed to investigate whether gowns currently worn by surgeons result in a breach of this protective clothing.

**Method**

The study was conducted at 06:00 on a Wednesday morning, a quiet time for surgery so as to ensure the largest possible sample of footwear was available. All gumboots present in the changing rooms of Christchurch Public Hospital were inspected internally for the presence of blood. Other types of theatre footwear were not studied. To be included gumboots had to be in the theatre changing rooms at the time and part of an obvious pair.

A total of 94 pairs of gumboots (91 from male surgeons and 3 from female surgeons) were inspected. The internal lining of each gumboot was carefully inspected visually for stains. Each identified stain was tested to confirm the presence or absence of blood. Testing was performed by dipping a Combur² Test® urine dipstick (Roche Diagnostics Limited, Charles Avenue, Burgess Hill, West Sussex, UK) in sterile water and then holding the dipstick against the stained area for 5 seconds. A change from yellow to green visible to the naked eye on the blood/haemoglobin indicator was recorded as a positive test. According to manufacturers specifications these dipsticks have a practical detection limit of 5 RBC/µL and accuracy > 90% when compared with a counting chamber.

If visible stains were confirmed to be blood by dipstick analysis then the gumboots were considered contaminated. The stains were further classified by size. Each stain was compared to a 20 mm² piece of card and was designated as either small (<20 mm²) or large (>20 mm²).

Dimensions of gumboots were not recorded in this study.

**Results**

Ninety-four pairs of gumboots (91 from male surgeons, 3 from female surgeons) were checked for internal contamination. Of these a total of 55 pairs (58.5%) had evidence of bloodstaining on the inside lining. Twenty percent of these were small stains of less than 20 mm², 80 % were larger than this (see Table 1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Not contaminated (%)</th>
<th>Small stain &lt;20 mm² (%)</th>
<th>Large stain &gt;20 mm² (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male boots</td>
<td>36 (40)</td>
<td>11 (12)</td>
<td>44 (48)</td>
<td>91</td>
</tr>
<tr>
<td>Female boots</td>
<td>3 (100)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>39 (41)</td>
<td>11 (12)</td>
<td>44 (47)</td>
<td>94</td>
</tr>
</tbody>
</table>

Among the gumboots of male surgeons 55 (60%) were contaminated on the inside with 80% of these having “large” amounts of staining. The 3 pairs of gumboots from the female changing rooms checked did not have any visible stains.

**Discussion**

Ensuring the safety of individuals in any workplace should be a high priority. Although performing surgery is not considered a “high-risk” task, it does carry some
danger of transmitted infection. In this study it was found that of a sample of 94 pairs of gumboots in use at our hospital, 58.5% were contaminated internally by blood. The majority (80%) of these stains were larger than 20 mm$^2$. Of the total gumboots checked only 3 were retrieved from the female changing rooms and none of these were contaminated.

One previous study looked at contamination of operating theatre footwear by blood or other infectious material. The study investigated for blood on the outside of surgical footwear after the items had been cleaned; no studies have been published about contamination of the inside of theatre footwear. Blood or other infectious material was found on 44% of boots externally. The main conclusion from this study was that the manual cleaning of surgical footwear being performed at the time was unsatisfactory. At Christchurch Public Hospital manual cleaning of gumboots is performed by Operating Theatre Assistants and there is no internal cleaning of gumboots done.

Harris and Schecter in a review of the approach to patients with HIV suggested the use of a cystoscopy apron as a precaution to provide a higher level of protection from blood splash. They further suggested the use of rubber boots that would cover the feet and legs up to the level of the cystoscopy apron.

In the current study blood stains found within gumboots were classified as either small (<20 mm$^2$) or large (>20 mm$^2$). The choice of 20 mm$^2$ as the cutoff was arbitrary, however the purpose of making this distinction was to indicate that the majority of bloodstains were more significant than a few drops. This was deemed to be important as larger bloodstains would presumably present a greater risk of transmitting infection.

The risk of infection from the type of contact that occurs from blood entering gumboots is very difficult to quantify. The risk would depend on the prevalence of blood borne illnesses in the population, the amount of blood in the boots, the presence of broken skin at this site, as well as the immunisation status of surgeons.

In general, the risk of becoming HIV positive following occupational exposure to blood is low. Epidemiological studies from UK healthcare setting estimate the average risk for HIV transmission following percutaneous exposure to HIV-infected blood to be about 0.3%. With mucocutaneous exposure the risk drops to less than 0.1% and is considered to be nil following contact with intact skin.

Healthcare workers can be protected against hepatitis-B virus by immunisation. The vaccine provides protection in 85-95% of recipients, although this protection decreases to 70% by 60 years of age. Occupational exposure is rare, but the consequences can be serious. The risk of acquiring hepatitis-C virus has been estimated at 1.5–3% after contact with infected blood. There is currently no immunisation or post-exposure prophylaxis for hepatitis-C virus in New Zealand.

Viral markers of HBV, HCV and HIV remain in dried blood that has been at room temperature for up to 5 weeks. This would suggest that any risk of infection might be increased by the multiple exposures to a bloodstain that could occur over a period of weeks. Despite this evidence it is difficult to know how long the risk of transmission remains even though laboratory tests are able to detect the virus.
Whatever the prevalence of these illnesses in a population, any exposure to blood must be deemed as a possible risk and should be eliminated. For this reason the idea of universal precautions has been adopted throughout the world. A survey of health care workers in Nigeria found that less than two-thirds of all respondents regularly wore appropriate protective garments.\(^9\)

Although the risks for transmission in New Zealand are likely to be significantly lower than in Nigeria it is important that universal precautions are adopted to minimise any risk that does exist. All blood should be considered to be infectious and handled in a manner consistent with this.

Since the realisation of the dangers of blood borne infections, there has been a great deal of interest in the permeability of surgical gowns.\(^10\) The inability of a gown to provide protection due to penetration by fluid material is known as strikethrough. It is unlikely that strikethrough is to blame for the blood that was found within gumboots in this study. The most likely cause would seem to be run off from gowns into the open neck of gumboots. Alternative methods or materials used for draping patients for surgery may help reduce run off of blood or other body fluids.

The practical aspects of providing longer gowns needs to be considered. Among surgeons there is variation in height. To provide gowns long enough to fully protect the wearer but also not so long as to touch the floor would require more variations in size. This would require more space in operating theatres, more frequent stocking of supplies and also a one off outlay to purchase new gowns. An alternative would be to stock disposable gowns of varying sizes.

An alternative to longer gowns might be longer gumboots or tighter fitting gumboots. This is probably less practical than wearing appropriate length gowns.

The major problem faced by this study is the inability to equate the presence of blood in gumboots with actual risks of infection. The detection of blood is being used as a surrogate marker for infection risk. Because detecting actual incidents of transmission of infection would require huge numbers and highly specific testing it is unrealistic in this setting.

This study was not able to identify the manner in which gumboots were contaminated. The hypothesis that longer gowns would reduce gumboot contamination rests on the theory that contamination occurs through run-off from gowns into gumboots. Although this seems the most likely cause it is not proven to be the case by this study.

This study could not show the number of exposures to blood that the inside of each gumboot had undergone. Presumably a single exposure would present less risk of a blood borne infectious agent being present than multiple exposures.

A further problem arose through not knowing the age of the gumboots, some uncontaminated boots may have been new or only used a few times. This may have led to underestimation of actual contamination rates. The small number of gumboots retrieved from the female change rooms also made any comparisons between genders speculative.

Although high rates of contamination were detected by this study it is difficult using current understanding to quantify the actual risks posed to surgeons through this type of contamination. The cost of providing longer gowns and a greater variety of sizes
would need to be weighed against the risk of infection. Presumably, because the outcome of infection for a surgeon is so serious, any risk would seem too great. Therefore, it follows that if internal contamination of gumboots were considered to pose any risk then addressing the issue is essential.

Overall, the high percentage of boots that were contaminated by blood in this study suggests that the length of the gowns in common use is not suitable for offering adequate protection for surgeons.

On the basis of this finding the authors would recommend that the option of longer gowns be available to health care workers to ensure their comfort and safety. Ongoing audits of contamination could be done to assess the effectiveness of this measure.

**Competing interests:** None.

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**References:**


